Am. J. Trop. Med. Hyg., 72(6), 2005, pp. 655–657
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LETTERS TO THE EDITOR
REMOTE SENSING OF MALARIA IN URBAN AREAS: TWO SCALES, TWO PROBLEMS

Dear Sir:

Two articles published in a supplement of the *American Journal of Tropical Medicine and Hygiene* make assertions about the use of remote sensing (RS) in urban areas that warrant further discussion. One evaluates qualitatively the impact of an eight-year investment of US$17 million by the Japanese International Corporation Agency (JICA) to control urban malaria in Dar es Salaam,[1] and the other investigates the impact of urbanization on malaria in sub-Saharan Africa and the implications of this for control.[2]

The first article states, after a limited investigation of aerial photography, that only optical imagery of 1 × 1 meter or finer spatial resolution is of use in delineating water-bodies for mapping malaria risk in urban areas,[1] a point further emphasized in an accompanying article.[3] The investigators then discuss the feasibility of the existing optical sensors in providing this information against issues of cost and opportunities for cloud free observation at tropical latitudes. There is a significant history of discussing these issues[4–9] that cite many examples of the cost-effectiveness of using aerial photography for mosquito larval habitat identification during control operations. Two further points should be made. The first is that exclusive use of optical sensors is not ideal for water-body discrimination, particularly in the cloudy tropics. Synthetic aperture radar (SAR) sensors are independent of solar radiation and thus can capture images at night and through complete cloud cover.[7] They have the further advantages of significant interaction of microwaves with water[10] and lower cost (e.g., complete coverage of Kenya at 25 × 25 meter spatial resolution with Radarsat US$5000 [Radarsat International http://www.rsi.ca/]). Furthermore, SAR imagery will soon be available at 1 × 1 meter spatial resolution from a variety of sources (e.g., http://www.terrasar.de/ and http://alos.nasda.go.jp). The second clarification is that not all remote sensing of urban areas[11–13] is focused explicitly on improving the ability of operational staff to identify larval habitats for larvicidal applications. Many studies have found that coarser resolution sensor information is also useful for identifying mosquito habitats.[12]

The second article attempts to estimate malaria incidence in African urban areas using an approach of dubious accuracy.[2] In the calculation of the land area that is urban in Africa, the investigators use night-time lights' imagery[14] developed by the Defense Meteorological Satellite Program for the National Oceanic and Atmospheric Administration. The use of these data in demographic applications has a substantial pedigree in RS. In night-time lights imagery, however, considerable contamination of dark pixels can occur from adjacent bright pixels (a phenomenon known as blooming) and adjustments need to be made. The RS specialist must therefore balance the likely underestimate of urban centers because some of these lack bright lights (factors between two and three are applied to allow for this effect) and the certain overestimate of other urban areas through blooming effects.[14–18] When only the first factor is considered, between 1.7% and 2.6% of Africa is estimated to be urban[2]; this is likely to be an overestimate because of the second effect. In a recent analysis of settlement patterns in Kenya,[18] a number of estimates of urban areas were tested. Those incorporating night-time lights imagery predicted significantly larger urban areas than those using visual interpretation of satellite imagery (http://www/africover.org). The most recently available Global Urban Rural Mapping Project[19,20] reported that only 0.8% of the surface of Africa is urban. Extrapolating these values to malaria incidence using only eight studies, and thereby claiming 6–28% of the global malaria incidence may occur in African urban areas,[2,3] should therefore be treated with caution because it is almost certainly an overestimate of unknown magnitude.

Simon I. Hay is supported by a Research Career Development Fellowship from the Wellcome Trust (#069045).

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